Macurco Refrigerants

Macurco Gas Detection Products

Macurco
Refrigerants
Training

MACURCO GAS DETECTION

Refrigerant History

- The first practical refrigerating machine was built by Jacob Perkins in 1834; it used ether in a vapor-compression cycle
- The first absorption machine was developed by Edmond Carr, in 1850, using water and sulfuric acid. His brother, Ferdinand Carr, demonstrated an ammonia/water refrigeration machine in 1859
- A mixture called chemogene, consisting of petrol ether and naphtha, was patented as a refrigerant for vapor-compression systems in 1866. Carbon dioxide was introduced as a refrigerant in the same year
- Ammonia was first used in vapor-compression systems in 1873, sulfur dioxide and methyl ether in 1875, and methyl chloride in 1878

Refrigerant History

- Nearly all of the early refrigerants were flammable, toxic, or both, and some also were highly reactive. Accidents were common
- The task of finding a nonflammable refrigerant with good stability was given to Thomas Midgley in 1926. He already had established himself by finding tetraethyl lead, to improve the octane rating of gasoline
- Midgley found that the refrigerants then in use comprised few chemical elements, clustered in the periodic table of elements. The element at the intersection was fluorine
- Within three days of starting, Midgley and his colleagues had identified and synthesized dichlorodifluoromethane, now known as R-12

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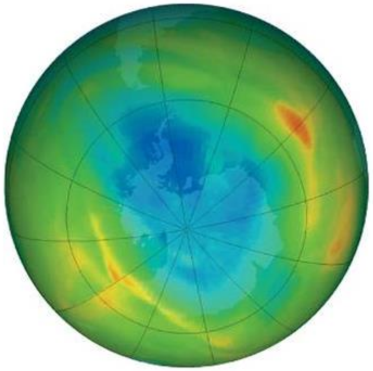
Refrigerant History

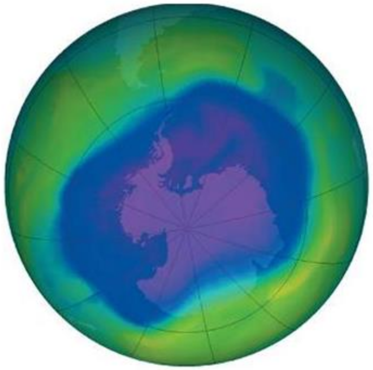
- Commercial chlorofluorocarbon (CFC) production began with R-12 in early 1931, R-11 in 1932, R-114 in 1933, and R-113 in 1934; the first hydrochlorofluorocarbon (HCFC) refrigerant, R-22, was produced in 1936
- By 1963, these five products accounted for 98% of the total production of the organic fluorine industry. Annual sales had reached 372 million pounds, half of it R-12
- These chlorofluorochemicals were viewed as nearly nontoxic, nonflammable, and highly stable in addition to offering good thermodynamic properties and materials compatibility at low cost

Refrigerant History

- Close to half a century passed between the introduction of CFCs and recognition of their harm to the environment when released
- Specific concerns relate to their depletion of stratospheric ozone and to possible global warming by actions as greenhouse gases
- Ironically, the high stability of CFCs enables them to deliver ozone-depleting chlorine to the stratosphere
- The same stability prolongs their atmospheric lifetimes, and thus their persistence as greenhouse gases



September 1979



September 2006

Refrigerant Toxicity

- Most CFCs are very stable in the atmosphere and generally have comparable or greater acute toxicity than HCFCs or HFCs
- One of the reasons that toxicity concerns have surfaced with the introduction of new refrigerants is that the new chemicals are somewhat less stable when released and exposed to air, water vapor, other atmospheric chemicals, and sunlight
- This increased reactivity is desired to reduce atmospheric longevity, and thereby to reduce the fraction of emissions that reaches the stratospheric ozone layer or that persists in the atmosphere as a greenhouse gas
- While (human) toxicity often increases with higher reactivity, atmospheric reactivity is not necessarily pertinent

http://www.epa.gov/ozone/snap/refrigerants/safety.html

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Refrigerant Safety Classifications

- Refrigerant safety group classifications consist of two alphanumeric characters (e.g. A2); the capital letter corresponds to toxicity and the digit to flammability
- Toxicity classification - Refrigerants are divided into two groups according to toxicity:
  - Class A signifies refrigerants for which toxicity has not been identified at concentrations less than or equal to 400 ppm
  - Class B signifies refrigerants for which there is evidence of toxicity at concentrations below 400 ppm

Refrigerant Safety Classifications

- Flammability classification - Refrigerants are divided into three groups according to flammability:
  - Class 1 indicates refrigerants that do not show flame propagation when tested in air at 21°C and 101 kPa
  - Class 2 indicates refrigerants having a lower flammability limit of more than 0.10 kg/m3 at 21°C and 101 kPa and a heat of combustion of less than 19 kJ/kg
  - Class 3 indicates refrigerants that are highly flammable as defined by a lower flammability limit of less than or equal to 0.10 kg/m3 at 21°C and 101 kPa or a heat of combustion greater than or equal to 19 kJ/kg

http://www.epa.gov/ozone/snap/refrigerants/safety.html

Refrigerant Safety Classifications

Hydrochlorofluorocarbures (HCFC)			
R22	chlorodifluoromethane	$CHClF_2$	A1
R141b	1,1-dichloro-1-fluoroethane	CH_3CCl_2F	A2
R142b	1-chloro-1,1-difluoroethane	CH_3CClF_2	A2
Hydrofluorocarbons (HFCs)			
R32	difluoromethane	CH_2F_2	A2
R125	pentafluoroethane	CHF_2CF_3	A1
R134a	1,1,1,2-tetrafluoroethane	CH_2FCF_3	A1
R143a	1,1,1-trifluoroethane	CH_3CF_3	A2
R152a	1,1-difluoroethane	CH_3CHF_2	A2
Azeotropic mixtures			
R502		R22/R115 (48.8/51.2)	A1
R507		R125/R143a (50/50)	A1
Zeotropic mixtures			
R404A		R125/R143a/R134a (44/52/4)	A1
R407C		R32/R125/R134a (23/25/52)	A1
R410A		R32/R125 (50/50)	A1

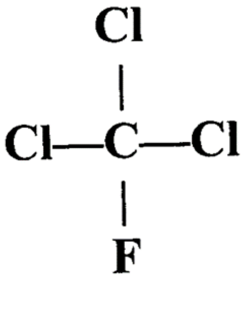
http://www.iifiir.org/userfiles/file/webfiles/summaries/Refrigerant_classification_EN.pdf

Refrigerant Categories

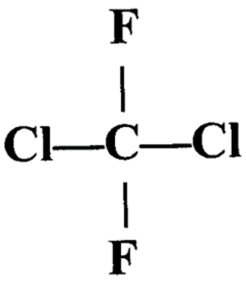
- There is a wide variety of refrigerants used in air conditioning equipment depending on the application. In general the most common refrigerants used in the industry belong to the following three categories
- Chlorofluorocarbons (CFCs)
- Hydrochlorofluorocarbons (HCFCs)
- Hydrofluorocarbons (HFCs)
- HFCs - such as R-134a are the new refrigerants and are being used in the newer machines to replace the CFC and HCFC
- Blends - There are many common blends that include either R-12, R-22, R-125 or R-134a

Chlorofluorocarbons (CFCs)

- These are the Chloro-fluoro-carbon refrigerants, such as R11, R12, R113, R114, etc.
- These refrigerants were identified as the most harmful to Ozone layer by the Montreal Protocol, and were phased out in 2000
- They are still being used in the older machines, with precautions to minimize release in accordance with EPA regulations
- The most common application of these refrigerant is in the large centrifugal chillers
- R12 was also used commonly in the older cars for air conditioning



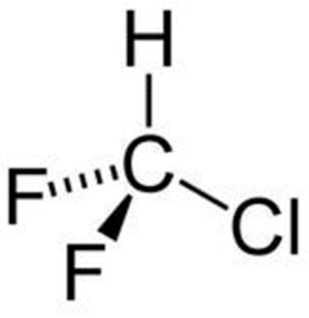
Freon-11



Freon-12

Hydrochlorofluorocarbon (HCFCs)

- These are the Hydro-chloro-fluoro-carbon refrigerants, such as R22, R123, etc.
- These refrigerants were identified as slightly harmful to the Ozone layer by Montreal Protocol, and will be completely phased out by 2030
- The R22 refrigerant is commonly used in reciprocating type of compressors
- R123 is used in centrifugal chillers as a temporary replacement for R11



HCFC
chlorodifluoromethane

Hydrofluorocarbon (HFCs)

- These are the Hydro-fluoro-carbon refrigerants, like R134a
- These are the new refrigerants that do not harm the Ozone layer, and are being used in the newer machines to replace the CFC and HCFC
- R134a is now commonly used as a replacement of R12 and R500 and in all new car air conditioners
- R407c is used as a replacement for R22. One of the other common HFC used in new equipment now is R410a
- Currently R134a is the most commonly used new HFC refrigerant. The various refrigerants have different characteristics, which make them suitable for a particular application

Hydrofluorocarbon (HFCs)

- The Macurco new RD-6 and RD-12 Refrigerant Detectors will be calibrated with R-134A and will detect:
  - R-22 Hydrochlorofluorocarbon (HCFC)
  - R-134a Hydrofluorocarbon (HFC)
  - R-404a Hydrofluorocarbon (HFC) Blend
  - R-407c Hydrofluorocarbon (HFC) Blend
  - R-410a Hydrofluorocarbon (HFC) Blend

Refrigerant 22

- R-22 is an HCFC refrigerant used for residential and commercial air conditioning and for medium- and low-temperature commercial refrigeration applications
- R-22 has been the refrigerant of choice for residential heat pump and air-conditioning systems for more than four decades. Unfortunately releases of R-22, such as leaks, contribute to ozone depletion
- As the manufacture of R-22 is phased out over the coming years manufacturers of residential air conditioning systems are offering equipment that uses ozone-friendly refrigerants
- Since January of 2003, the price of R-22 in the U.S. market has increased by more than 500%, and the supply reductions created by ongoing regulations are likely to continue to influence R-22 price

http://www.epa.gov/ozone/title6/phaseout/22phaseout.html

Refrigerant 134a

- R-134a can be used in many applications that currently use dichlorodifluoromethane (R-12). These include refrigeration and aerosol products
- R-134a is nonflammable and has low toxicity which makes it a very efficient and safe replacement refrigerant for R-12 in many segments of the refrigeration industry
- Most notably in automotive air conditioning, appliances, small stationary equipment, medium temperature supermarket cases, and industrial and commercial chillers
- Most notably in automotive air conditioning, appliances, small stationary equipment, medium temperature supermarket cases, and industrial and commercial chillers
- R-134a can be used as a replacement for R-12 and R-141b in thermoset foams

http://www2.dupont.com/Refrigerants/en_US/assets/downloads/h45945_hfc134a_push.pdf

Refrigerant 404a

- R-404a is a non-ozone depleting, blend of R-125, R-143a, and R-134a and is formulated to match the properties of R-502, making it useful for a variety of medium and low temperature refrigeration applications
- R-404A leads the way as the global industry standard HFC refrigerant for new commercial refrigeration applications
- R-404A delivers exceptional performance as an R-502 and R-22 replacement
- R-404A is for use in new refrigeration in food display and storage cases, cold storage rooms, ice machines, transportation and process refrigeration

http://americas.forane.com/en/forane-refrigerants/our-products/product-viewer/Forane-404A/

Refrigerant 407c

- R-407c is an HFC alternative for R-22 in positive displacement air conditioning equipment. It is currently being used in commercial and light commercial a/c units using air cooled DX chillers
  - R-407c can also be used in many medium temperature refrigeration systems that formerly used R-22
  - R-407c can also be used to replace R-502 in new and existing medium-temperature applications with evaporator temperatures above 20°F
  - R-407c is a refrigerant blend: It is a blend of R-32, R-125 and R-134a (23/25/52 wt%)

http://www2.dupont.com/Refrigerants/en_US/assets/downloads/h92030_Suva407C_faq.pdf

Refrigerant 410a

- R-410a is a 50/50 blend of R-32 and R-125 refrigerants that is used in residential and light commercial air conditioning and heat pump systems
- R-410a has shown to have a 5-6% higher Energy Efficiency Rating (EER) than R-22
- R-410a also has a higher capacity and pressure than R-22, allowing for the design of smaller, more compact air conditioning equipment
- These higher pressures meant redesign of 3 key parts to an air conditioning system - compressor, condensing coil and evaporator coil - are now more sturdy to hold up to the new refrigerant pressure demand
- R-410A also provides comparable performance to R-13B1 in most very low temperature (VLT) applications

http://www.classicairconditioning.net/puron.html

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Ammonia

- Ammonia is not a universal refrigerant, and mainly suitable for industrial and heavy commercial applications
- Ammonia’s toxicity, flammability and material compatibility have to be taken in to account, though there is a huge global population of ammonia systems where those challenges are successfully dealt with
- Due to success of CFC’s, Ammonia came under pressure, but held on, especially in large industrial installations and food preservation
- In 1980’s the harmful effects of CFC refrigerants became apparent and it was generally accepted that the CFC refrigerants are contributing to depletion of ozone layer and to global warming, finally resulting in Montreal protocol (1989) where almost all countries agreed to phase out CFC’s in a time bound program

Ammonia Classification

INORGANIC COMPOUND			
R717	ammonia	NH_3	B2
R718	water	H_2O	A1
R744	carbon dioxide	CO_2	A1
ORGANIC COMPOUND			
Hydrocarbons			
R170	ethane	CH_3CH_3	A3
R290	propane	$CH_3CH_2CH_3$	A3
R600a	isobutane	$CH(CH_3)_2CH_3$	A3
Halocarbons			
Chlorofluorocarbons (CFCs) and Bromofluorocarbons (BFCs)			
R11	trichlorofluoromethane	CCl_3F	A1
R12	dichlorodifluoromethane	CCl_2F_2	A1

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Advantages of Ammonia

- Energy efficiency - Ammonia is one of the most efficient applications out there, with the application range from high to low temperatures. With the ever increasing focus on energy consumption, ammonia systems are a safe and sustainable choice for the future
- Environment - Ammonia is the most environmentally friendly refrigerant. It belongs to the group of so called “natural” refrigerants, and it has both Global Warming Potential and Ozone Depletion Potential equal to zero
- Safety - Ammonia is a toxic refrigerant, and it is also flammable at certain concentrations. That is why it has to be handled with care, and all ammonia systems have to be designed with safety in mind. At the same time, unlike most other refrigerants, it has a characteristic odor that can be detected by humans even at very low concentrations. That gives a warning sign even in case of minor ammonia leakages.

Advantages of Ammonia

- Smaller pipe sizes - In both vapor and liquid phase ammonia requires smaller pipe diameters than most chemical refrigerants
- Better heat transfer - Ammonia has better heat transfer properties than most of chemical refrigerants and therefore allow for the use of equipment with a smaller heat transfer area. Thereby plant construction cost will be lower. But as these properties also benefit the thermodynamic efficiency in the system, it also reduces the operating costs of the system
- Refrigerant price - In many countries the cost of ammonia (per kg) is considerably lower than the cost of HFCs. This advantage is even multiplied by the fact that ammonia has a lower density in liquid phase. Furthermore as any leakage of ammonia will be detected very quickly due to the odor, hence any potential loss of refrigerant will also be lower

http://www.danfoss.com/BusinessAreas/RefrigerationAndAirConditioning/Refrigerants/WhyAmmonia.htm

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Gas Detection. It's What We Do.